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(54) **ELECTRONIC LOCKING SYSTEM**

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See application file for complete search history.

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(57) **ABSTRACT**

An electronic locking system provided with an electronic lock may include a lock detecting part to detect locking condition of the lock; a power outage-detecting part to detect power outage; a charging part to supply electric power to the lock during power outage; a power-supplying part to supply power to the lock and charging part; and a switching part structured such that power is supplied to the lock from the power-supplying part in a primary state, and power is supplied to the electronic lock from said charging part in a secondary state. The switching part is in said primary state during normal operation where no power outage is detected. The switching part is structured such that, when power outage is detected, said switching part is switched from said primary state to said secondary state.

8 Claims, 2 Drawing Sheets

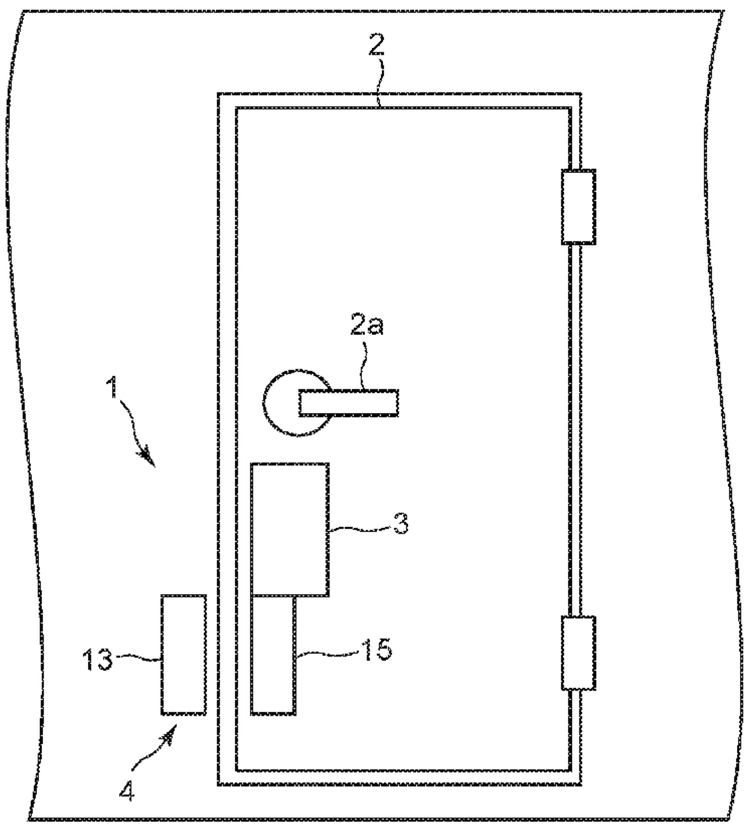


FIG. 1

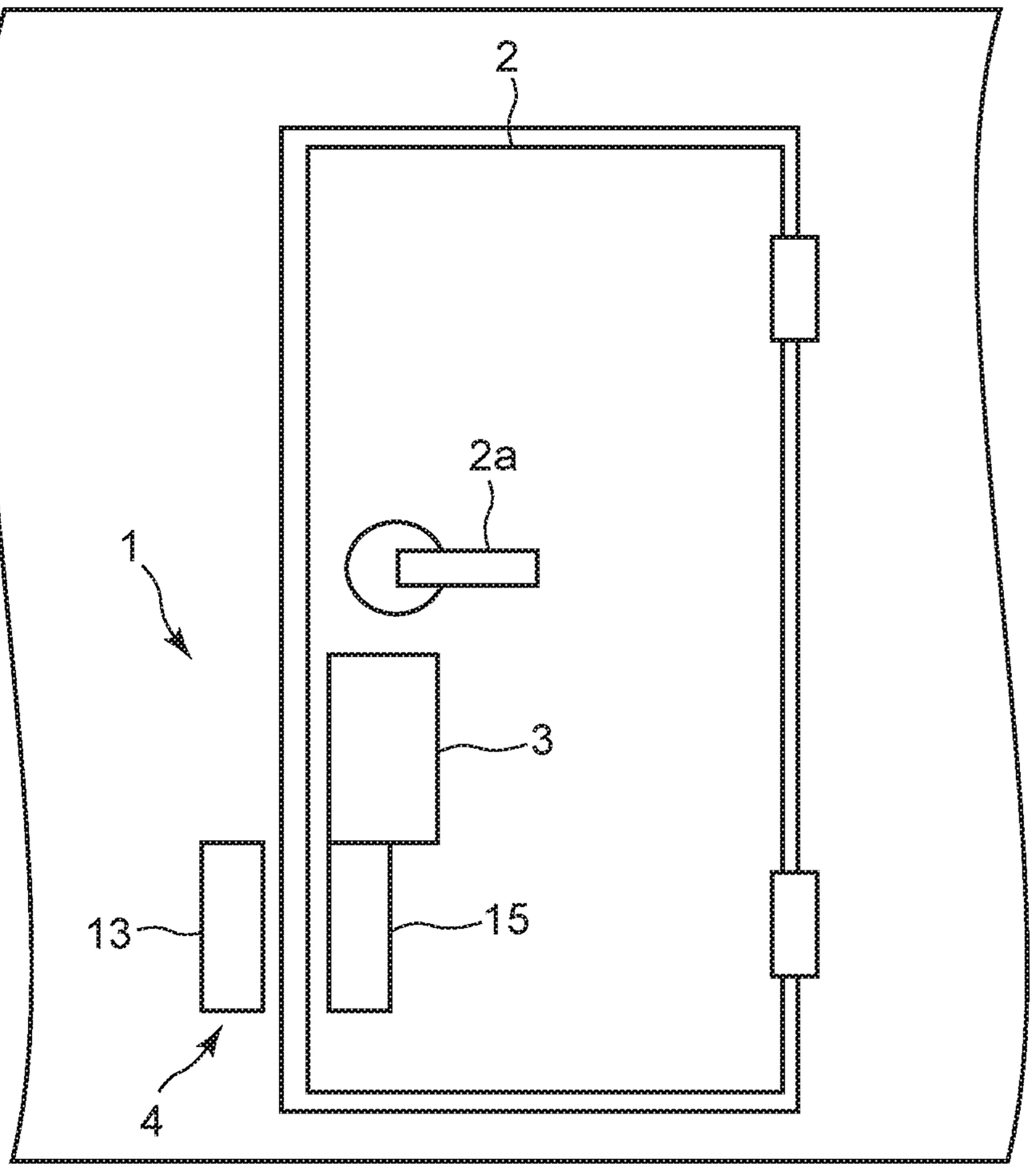
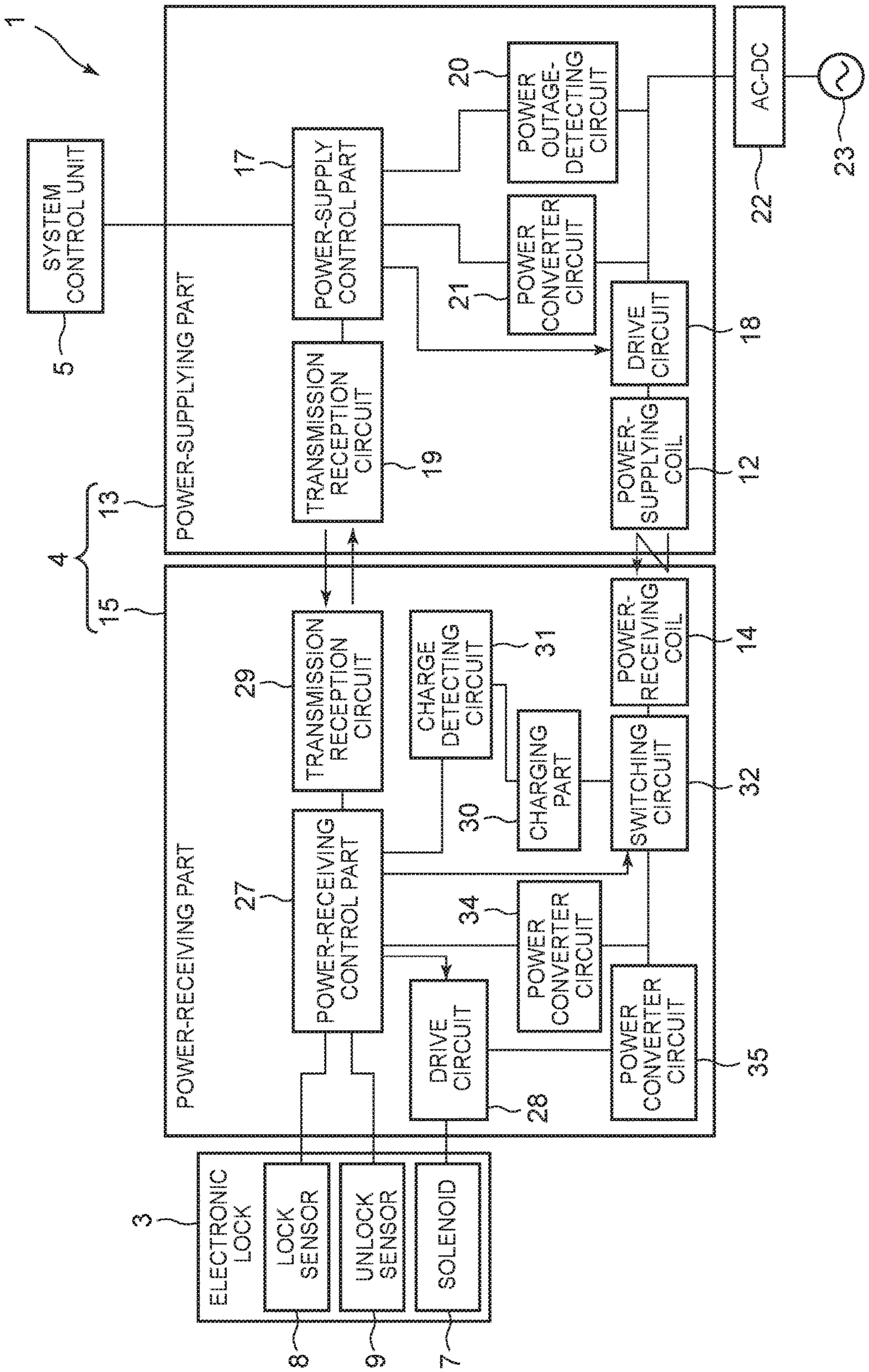


FIG. 2


1
SYSTEM CONTROL UNIT
5
POWER-SUPPLYING PART
17
POWER-SUPPLY CONTROL PART
20
POWER OUTAGE-DETECTING CIRCUIT
21
POWER CONVERTER CIRCUIT
DRIVE CIRCUIT
18
AC-DC
22
23
TRANSMISSION RECEPTION CIRCUIT
19
POWER-SUPPLYING COIL
12
4
13
15
POWER-RECEIVING PART
29
TRANSMISSION RECEPTION CIRCUIT
CHARGE DETECTING CIRCUIT
31
30
CHARGING PART
SWITCHING CIRCUIT
POWER-RECEIVING COIL
14
32
27
POWER-RECEIVING CONTROL PART
34
POWER CONVERTER CIRCUIT
DRIVE CIRCUIT
28
POWER CONVERTER CIRCUIT
35
3
ELECTRONIC LOCK
LOCK SENSOR
UNLOCK SENSOR
SOLENOID
8
9
7

ELECTRONIC LOCKING SYSTEM

CROSS REFERENCE TO RELATED APPLICATION

The present invention claims priority under 35 U.S.C. § 119 to Japanese Application No. 2015-014525 filed Jan. 28, 2015, the entire content of which is incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates to an electronic locking system provided with an electronic lock.

BACKGROUND

Conventionally known is an electronic lock which is locked when powered (Patent reference 1, for example). An electronic lock, disclosed in Patent reference 1, is locked when electric power is supplied and unlocked when electric power supply is interrupted. Therefore, when power outage occurs and electric current supply to the electronic lock is interrupted, the lock is automatically unlocked. Conventionally also known is an electronic lock which is unlocked when powered. This type of electronic lock is unlocked when electric power is supplied and locked when electric power supply is interrupted. Therefore, this type of electronic lock is automatically locked when power outage occurs and electric current supply to the electronic lock is interrupted.

PATENT REFERENCE

[Patent Reference 1] Unexamined Japanese Patent Application Publication 2008-214872

As described above, the electronic lock which is locked when powered has an advantage that the lock is automatically unlocked when power outage occurs and therefore power is not supplied. On the other hand, the electronic lock which is unlocked when powered has an advantage that the lock is automatically locked when power outage occurs and therefore electric power is not supplied. However, the electronic lock which is locked when powered constantly consumes electricity while in the locked condition, increasing power consumption. In the same manner, the electronic lock which is unlocked when powered constantly consumes power while in the unlocked condition, increasing power consumption.

Therefore, at least an embodiment of the present invention provides an electronic locking system capable of reducing power consumption while maintaining the advantage of an electronic lock which is locked when powered. Also, at least an embodiment of the present invention provides an electronic locking system capable of reducing power consumption while maintaining the advantage of an electronic lock which is unlocked when powered.

To achieve the above, the electronic locking system of at least an embodiment of the present invention, having an electronic lock which becomes unlocked during the time of power outage, comprises a lock detecting part for detecting that the electronic lock is in the locked condition, a power outage-detecting part for detecting power outage, a charging part for supplying electric power to the electronic lock during the time of power outage, a power-supplying part for supplying electric power to the electronic lock and the charging part, and a switching part which is switched between a primary state, in which electric power can be supplied to the electronic lock from the power-supplying part, and a secondary state, in which electric power can be supplied to the electronic lock from the charging part; wherein the electronic lock is an electronic lock which is instantly locked/unlocked when powered or a motor-driven locking/unlocking type electronic lock; at a normal time where no power outage is detected, the switching part is in the primary state; when the electronic lock is switched from the unlocked condition to the locked condition or from the locked condition to the unlocked condition, electric power is supplied to the electronic lock from the power-supplying part; when power outage is detected based on the detection result at the power outage detecting part and also it is detected based on the detection result by the lock detecting part that the electronic lock is in the locked condition, the switching parties switched from the primary state to the secondary state, power is supplied to the electronic lock from the charging part, and then the electronic lock becomes unlocked.

The electronic locking system of at least an embodiment of the present invention is equipped with the switching part switching between the primary state, in which electric current can be supplied by the electric power-supplying part to the electronic lock, and the secondary state, in which electric current can be supplied to the electronic lock by the charging part. In at least an embodiment of the present invention, also, when power outage is detected based on the detection result at the power outage detecting part and it is detected based on the detection result by the lock detecting part that the electronic lock is in the locked condition, the switching parties switched from the primary state to the secondary state at which power is supplied to the electronic lock by the charging part and the electronic lock becomes unlocked. In other words, in at least an embodiment of the present invention, when power outage is detected and it is also detected that the electronic lock is in the locked condition, the switching parties automatically switched from the primary state to the secondary state, without a user's operation, to supply electric current to the electronic lock from the charging part so that the electronic lock which was in the locked condition when power outage occurred becomes unlocked immediately after the power outage occurs. For this reason, the electronic locking system of at least an embodiment of the present invention has an advantage of an electronic lock which is locked when powered that, when power outage occurs and no electric current is supplied to the electronic lock, the electronic lock automatically becomes unlocked. Also, in at least an embodiment of the present invention, the electronic lock is an electronic lock which is instantly locked/unlocked when powered or a motor-driven locking/unlocking type electronic lock, in which power is consumed when the electronic lock is switched from the unlocked condition to the locked condition or from the locked condition to the unlocked condition. Therefore, in the preset invention, the power consumption by the electronic locking system can be reduced. Thus, in the electronic locking system of at least an embodiment of the present invention, the power consumption by the electronic locking system can be reduced while having the advantage of an electronic lock which is locked when powered.

Also, in at least an embodiment of the present invention, electric power is supplied to the electronic lock from the power-supplying part when the electronic lock is switched from the unlocked condition to the locked condition or from the locked condition to the unlocked condition during normal operation where no power outage is detected by the

power-outage detecting part. When power outage is detected and it is also detected that the electronic lock is in the locked condition, electric power is supplied from the charging part. Therefore, in at least an embodiment of the present invention, the charging part charges and discharges less frequently. Therefore, in at least an embodiment of the present invention, the life of the charging part can be increased.

To achieve the above, the electronic locking system of at least an embodiment of the present invention is an electronic locking system equipped with an electronic lock which is kept in the locked condition during the time of power outage, and comprises an unlock detecting part for detecting that the electronic lock is in the unlocked condition, a power outage-detecting part for detecting power outage, a charging part for supplying electric power to the electronic lock during the time of power outage, a power-supplying part for supplying electric power to the electronic lock and the charging part, and a switching part which is switched between the primary state, in which electric power can be supplied to the electronic lock by the electric power-supplying part, and the secondary state, in which electric power can be supplied to the electronic lock by the charging part; wherein the electronic lock is an electronic lock which is instantly locked/unlocked when powered or a motor-driven locking/unlocking type electronic lock; during normal operation where no power outage is detected, the switching part is in the primary state; when the electronic lock is switched from the unlocked condition to the locked condition or from the locked condition to the unlocked condition, electric power is supplied to the electronic lock by the power-supplying part; when power outage is detected based on the detection result by the power outage detecting part and it is also detected, based on the detection result by the unlock detecting part, that the electronic lock is in the unlocked condition, the switching part is switched from the primary state to the secondary state, electric power is supplied to the electronic lock by the charging part, and the electronic lock becomes locked.

The electronic locking system of at least an embodiment of the present invention is equipped with the switching part which is switched between the primary state, in which electric power can be supplied to the electronic lock by the power-supplying part, and the secondary state, in which electric power can be supplied to the electronic lock by the charging part. Also, in at least an embodiment of the present invention, when power outage is detected based on the detection result by the power outage detecting part and it is also detected, based on the detection result by the unlock detecting part, that the electronic lock is in the locked condition, the switching part is switched from the primary state to the secondary state, electric power is supplied to the electronic lock by the charging part, and then the electronic lock becomes locked. In other words, in at least an embodiment of the present invention, when power outage is detected and it is also detected that the electronic lock is in the locked condition, the switching part is automatically switched from the primary state to the second sate without a user's operation so that electric power is supplied to the electronic lock by the charging part; thus, the electronic lock which was in the unlocked condition when power outage occurred becomes locked immediately after the power outage occurs. For this reason, the electronic locking system of at least an embodiment of the present invention has an advantage of an electronic lock which is unlocked when powered, and in which the electronic lock automatically becomes locked when power outage occurs and no electricity is supplied to the lock. Also, in at least an embodiment of the present invention, the electronic lock is an electronic lock which is instantly locked/unlocked when powered or a motor-driven locking/unlocking type electronic lock, in [both of] which electric power is consumed when the electronic lock is switched from the unlocked condition to the locked condition or from the locked condition to the unlocked condition. Therefore, in at least an embodiment of the present invention, power consumption by the electronic locking system can be reduced. As described, in the electronic locking system of at least an embodiment of the present invention, power consumption by the electronic locking system can be reduced while having the advantage of an electronic lock which is unlocked when powered.

Also, in at least an embodiment of the present invention, electric power is supplied to the electronic lock by the power-supplying part when the electronic lock is switched from the unlocked condition to the locked condition or from the locked condition to the unlocked condition during normal operation where no power outage is detected by the power outage detecting part. Also, when power outage is detected and it is also detected that the electronic lock is in the unlocked condition, electric power is supplied to the electronic lock by the charging part. Therefore, in at least an embodiment of the present invention, the charging part charges and discharges less frequently. Thus, the life of the charging part can be increased in at least an embodiment of the present invention.

In at least an embodiment of the present invention, it is preferred that the electronic locking system be equipped with a charging current armature which is wound to be air-cored and connected to a power source and also be equipped with a power-receiving coil, as the power-supplying part, which is wound to be air-cored and arranged opposite the power-supplying coil with a predetermined gap, and that electric power be transmitted from the power-supplying coil to the power-receiving coil through contactless power transmission. With this configuration, there is no need to draw a wire between a fixture to which the electronic lock is mounted and a fixture frame; therefore, the construction of the electronic locking system can be simplified. Meanwhile, when power is supplied through contactless power transmission, efficiency in power transmission is lower than when power is supplied through a wire; therefore, power consumption by the electronic locking system may be greater even if the same amount of electric energy is supplied to the electronic lock or the charging part. However, in at least an embodiment of the present invention, the electronic lock is an electronic lock which is locked/unlocked when powered or a motor-driven locking/unlocking type electronic lock, where electricity is consumed only when the electronic lock is switched from the unlocked condition to the locked condition or from the locked condition to the unlocked condition; therefore, even when electric power is supplied through contactless power transmission, the overall power consumption by the electronic locking system can be reduced.

In at least an embodiment of the present invention, it is preferred that the electronic locking system be equipped with a charge detecting part for detecting that the charging of the charging part is completed, the switching part keep the current-receiving coil and the charging part electrically connected until the charging part is charged completely and then electrically disconnect the current-receiving coil from the charging part as soon as the charge to the charging part is completed, electric power needed to operate the electronic lock and electric power needed to charge the charging part be transmitted from the power-supplying coil to the power-

receiving coil when the electronic lock is in operation before the charge to the charging part is completed, and electric power needed to operate the electronic lock be transmitted from the power-supplying coil to the receiving coil when the electronic lock is in operation after the charging of the charging part is completed. With this configuration, the electric power transmitted from the power-supplying coil to the power-receiving coil can be kept to a minimum requirement when the electronic lock is in operation. Therefore, even if the electric power is supplied through contactless power transmission, the overall power consumption by the electronic locking system can effectively be reduced.

In at least an embodiment of the present invention, it is preferred that the electronic locking system be equipped with a charge detecting part for detecting that the charging part is charged completely, the switching part keep the power-receiving coil and the charging part electrically connected until the charging of the charging part is completed and electrically disconnect the power-receiving coil from the charging part as soon as the charging of the charging part is completed, electric power needed to charge the charging part be transmitted from the power-supplying coil and the power-receiving coil when the electronic lock is not in operation before the charging of the charging part is completed, and power transmission from the power-supplying coil to the power-receiving coil is halted when the electronic lock is not in the operation after the charging of the charging part is completed. With this configuration, even if electric power is supplied through contactless power transmission, the overall power consumption by the electronic locking system can effectively be reduced.

EFFECTS OF THE INVENTION

As described above, in the electronic locking system of at least an embodiment of the present invention, power consumption by the electronic locking system can be reduced while having the advantage of an electronic lock which is locked when powered. Alternately, in the electronic locking system of at least an embodiment of the present invention, power consumption by the electronic locking system can be reduced while having the advantage of an electronic lock which is unlocked when powered.

BRIEF DESCRIPTION OF THE DRAWING

Embodiments will now be described, by way of example only, with reference to the accompanying drawings which are meant to be exemplary, not limiting, and wherein like elements are numbered alike in several Figures, in which:

[FIG. **1**] A diagram to explain the configuration of an electronic locking system of an embodiment of the present invention.

[FIG. **2**] A block diagram to explain the electrical configuration of the electronic locking system shown in FIG. **1**.

DETAILED DESCRIPTION OF THE INVENTION

At least an embodiment of the present invention are described hereinafter, referring to the drawings.

(Configuration of Electronic Locking System)

FIG. **1** is a diagram to explain the configuration of an electronic locking system **1** of an embodiment of the present invention. FIG. **2** is a block diagram to explain the electrical configuration of the electronic locking system shown in FIG. **1**.

The electronic locking system **1** of this embodiment is a system to lock a door **2** so that the door (a hinged door) **2** will not open, and is equipped with an electronic lock **3**, a power-supplying device **4** to power the electronic lock **3**, and a system control unit **5** for controlling the electronic locking system. Also, the electronic locking system **1** is equipped with a door open/close sensor (no illustration) for detecting the opened/closed condition of the door **2**. A door knob **2***a* is attached to the door **2**.

The electronic lock **3** is an electronic lock which is instantly locked/unlocked when powered. In other words, when the electronic lock **3** is switched from the unlocked condition to the locked condition or from the locked condition to the unlocked condition, electric power is supplied tithe electronic lock **3**; after the electronic lock **3** is switched from the unlocked condition to the locked condition or from the locked condition to the unlocked condition, power supply to the electronic lock **3** is halted. The electronic lock **3** is provided with a deadbolt (no illustration) and a solenoid **7** which drives the deadbolt. Also, the electronic lock **3** is provided with a lock sensor **8** for detecting that the electronic lock **3** is in the locked condition and an unlock sensor **9** for detecting that the electronic lock **3** is in the unlocked condition. The electronic lock **3** is built in the door **2**. The lock sensor **8** of this embodiment is a lock detecting part and the unlock sensor **9** is an unlock detecting part.

The power-supplying device **4** is a wireless type power-supplying device that supplies electric power to the electronic lock **3** (more specifically, the solenoid **7**) through contactless power transmission. This power-supplying device **4** is equipped with a power-supplying part **13** having a power-supplying coil **12** and a power-receiving part **15** having a power-receiving coil **14**. The power-receiving part **15** is built in the door **2**. The power-supplying part **13** is arranged inside of the outside frame to which the door **2** is swingingly mounted or inside of the wall to which the outside frame is fastened. The power-supplying coil **12** and the power-receiving coil **14** are air-cored coils which are wound to be air-cored.

The power-supplying part **13** is equipped with, in addition to the power-supplying coil **12**, a power-supply control part **17** for controlling the power-supplying part **13**, a drive circuit **18** for supplying electric current to the power-supplying coil **12**, a transmission reception circuit **19** for transmitting information with the power-receiving part **15**, and a power outage-detecting circuit **20** for detecting power outage. The power-supply control part **17** is connected to the system control unit **5** by a predetermined wiring, and information is transmitted between the power-supply control part **17** and the system control unit **5**.

The transmission reception circuit **19** is connected to the power-supply control part **17**. The power-supply control part **17** is connected to a power source **23** (more specifically, an AC power source) via a power converter circuit **21** and an analog-to-digital converter (ADC) **22**. The power converter circuit **21** converts the power which is supplied by the power source **23** via the ADC **22** into the power for control. Also, the power-supplying part **17** is equipped with a charging part such as a condenser; during the power outage, the power-supply control part **17** performs a predetermined control using the power supplied by the charging part.

The drive circuit **18** is connected to the power-supplying coil **12** as well as to the power source **23** via the ADC **22**. In other words, the power-supplying coil **12** is connected to the power source **23** via the drive circuit **18** and the ADC **22**. Also, the drive circuit **18** is connected to the power-supply control part **17**. Once the current supplying signal output

from the power-supply control part **17** is input to the drive circuit **18**, the drive circuit **18** supplies electric current to the power-supplying coil **12**.

The power outage-detecting circuit **20** is connected to the power-supply control part **17**, to which the power outage-detecting signal output from the power outage-detecting circuit **20** is input. Also, the power outage-detecting circuit **20** is connected to the power source **23** via the ADC **22**. The power outage-detecting circuit **20** oversees the voltage of the power source **23** which is connected thereto via the ADC **22**. Also, the power outage-detecting circuit **20** judges that power outage has occurred when the voltage of the power source **23** drops below a predetermined reference value. In other words, when the voltage of the power source **23** becomes lower than a predetermined reference value, power outage is detected by the power outage-detecting circuit **20**. Also, the power outage-detecting circuit **20** judges that power outage has occurred when the voltage of the power source **23** drops below a predetermined reference value and continually stays there for a predetermined period of time. In other words, when the condition in which the voltage of the power source **23** is below a predetermined reference value continues for a predetermined period of time, the power outage-detecting circuit **20** judges [lit: detects] it to be a power outage. The power-outage-detecting circuit **20** of this embodiment is a power outage-detecting part.

The power-receiving part **15** is provided with, in addition to the power-receiving coil **14**, a power-receiving control part **27** for controlling the power-receiving part **15**, a drive circuit **28** for supplying electric current to the solenoid **7** to drive the drive circuit **28**, and a communication circuit **29** for communicating information with the power-supplying part **13**. The power-receiving part **15** is also provided with a charging part for supplying electric power to the electronic lock during the power outage and a charge-detecting circuit **31** for detecting that the charging of the charging part **30** is completed. The power-receiving part **15** is further provided with a switching circuit **32** which is switched between the primary state in which power can be supplied to the electronic lock **3** by the power-receiving coil **14** and the secondary state in which power can be supplied to the electronic lock **3** by the charging part **30**. The power-receiving coil **14** of this embodiment is a power-supplying part for supplying electric power to the electronic lock **3** and the charging part **30**. Also, the charge-detecting circuit **31** of this embodiment is a charge-detecting part, and the switching circuit **32** is a switching part.

The power-receiving coil **14** is positioned opposite the power-supplying coil **12** with a predetermined gap when the door **2** is in the closed position. In the power-supplying device **4**, when electric current is supplied to the power-supplying coil **12** with the door **2** closed, the electric power is transmitted to the power-receiving coil **14** from the power-supplying coil **12** through contactless power transmission. In this embodiment, electric power is transmitted from the power-supplying coil **12** to the power-receiving coil **14** by a magnetic field coupling method. A lock sensor **8** and an unlock sensor **9** are connected to the power-receiving control part **27** so that the lock-detecting signal output from the lock sensor **8** and the unlock-detecting signal output from the unlock sensor **9** are to be input thereto. Also, the above-described door open/close senor is connected to the power-receiving control part **27** to which the door open/close signals output from the door open/close sensor are input.

The communication circuit **29** is connected to the power-receiving control part **27**. Between the communication circuit **19** and the communication circuit **29**, wireless data communication is going on when the door **2** is in the closed position. For instance, data communication is done between the communication circuit **19** and communication circuit **29** through an infrared transmission. The drive signals of the solenoid **7** and the power outage-detecting signals are transmitted from the communication circuit **19** to the communication circuit **29**; on the other hand, the lock detecting signals, the unlock detecting signals, the door open/close signals and the charge complete signals which will be described later are transmitted from the communication circuit **29** to the communication circuit **19**. In other words, via the communication circuits **19** and **29**, the drive signals of the solenoid **7** and the power outage-detecting signals are transmitted from the power supply control part **17** to the power-receiving control part **27**, and the lock detecting signals, the unlock detecting signals, the door open/close signals and the charge complete signals are transmitted from the power-receiving control part **27** to the power supply control part **17**.

Note that, as described above, the power supply control part **17** is connected to the system control unit **5** so that the drive signals, etc. of the solenoid **7** which are output from the system control unit **5** are input to the power supply control part **17**. More specifically described, the drive signals of the solenoid **7** to turn the electronic lock into the locked condition and the drive signals, etc. of the solenoid **7** to turn the electronic lock from the locked condition to the unlocked condition are output from the system control unit **5** and then input to the power supply control part **17**. Also, the power supply control part **17** outputs the lock-detecting signals, the unlock-detecting signals and the door open/close signals to the system control unit **5**.

The charging part **30** is a secondary battery (a storage battery) or a condenser. The charging capacity of the charging part **30** of this embodiment is relatively small and is charged with the electricity sufficient to drive the solenoid **7** once (that is, the electricity sufficient to turn the electronic lock **3** from the locked condition to the unlocked condition or from the unlocked condition to the locked condition). The charging part **30** is connected to the switching circuit **32**. The charge-detecting circuit **31** is connected to the power-receiving control part **27** and also connected to the charging part **30**. The charge complete signals, which are output from the charge-detecting circuit **31**, are input to the power-receiving control part **27**.

The switching circuit **32** is connected to the power-receiving coil **14** and the charging part **30**. Also, the switching circuit **32** is connected to the drive circuit **28** via a power converter circuit **35** which will be described later. Further, the switching circuit **32** is connected to the power-receiving control part **27** so that the switching signals to switch the switching circuit **32** from the above-described primary state to the secondary state is output from the power-receiving control part **27** and then input to the switching circuit **32**. The switching circuit **32** keeps the power-receiving coil **14** and the charging part **30** electrically connected until the charging of the charging part **30** is completed, and on the other hand, electrically disconnects the power-receiving coil **14** from the charging part **30** after the charging of the charging part **30** is completed. In this embodiment, when the power-receiving coil **14** and charging part **30** are electrically connected, the charging part **30** is also electrically connected to the solenoid **7** via the drive circuit **28** and a power converter circuit **35** which is described later. On the other hand, when the power-receiving coil **14** and the charging

part **30** are electrically disconnected from each other, the charging part **30** is also electrically disconnected from the solenoid.

The power-receiving control part **27** is connected to the power-receiving coil **14** via the power converter circuit **34** and the switching circuit **32** so that electric power can be supplied to the power-receiving control part **27** by the power-receiving coil **14** via the power converter circuit **34** and the switching circuit **32**. The power converter circuit **34** converts the electric power supplied by the power-receiving coil **14** into the power for control. Also, the power-receiving control part **27** is provided with the charging part such as the condenser; during the time of power outage, the power-receiving control part **27** performs predetermined controls with the electric power supplied from this charging part. Note that, in this embodiment, the electric power can be supplied to the power-receiving control part **27** by the charging part **30**.

The drive circuit **28** is connected with the solenoid **7** and also connected to the switching circuit **32** via the power converter circuit **35**. The power converter circuit **35** converts the power supplied from the power-receiving coil **14** or from the charging part **30** into the solenoid driving power. Also, the drive circuit **28** is connected to the power-receiving control part **27**. Once the drive signal output from the power-receiving control part **27** is input to the drive circuit **28**, the drive circuit **28** drives the solenoid **7**.

(Operation of Electronic Locking System)

In the electronic locking system **1**, the switching circuit **32** is kept in the primary state in which electric power can be supplied to the electronic lock **3** from the power-receiving coil **14** during normal operation where no power outage is detected by the power-outage detecting circuit **20**. More specifically described, in the switching circuit **32** under the condition before the charging is completed, the solenoid **7** and the power-receiving coil **14** are electrically connected, the power-receiving coil **14** and the charging part **30** are electrically connected and the solenoid **7** and the charging part **30** are electrically connected. In the switching circuit **32** under the condition after the charging is completed, the solenoid **7** and the power-receiving coil **14** are electrically connected, but the power-receiving coil **14** and the charging part **30** are electrically disconnected and the solenoid **7** and the charging part **30** are electrically disconnected. Note that the charging part **30** can be completely charged in a short time; therefore, when the switching circuit **32** is in the primary state, the solenoid **7** and the power-receiving coil **14** are normally electrically connected, but the power-receiving coil **14** and the charging part **30** are electrically disconnected and the solenoid **7** and the charging part **30** are electrically disconnected.

To operate the electrical lock **3** under this condition, when the system control unit **5** outputs the drive signal of the solenoid **7** and then the drive signal of the solenoid **7** is input to the power-supply control part **17**, the current-supply signal is input to the drive circuit **18** from the power-supply control part **17** and finally electric current is supplied to the power-supplying coil **12**. Once electric current is supplied to the power-supplying coil **12**, the electric power is transmitted from the power-supplying coil **12** to the power-receiving coil **14**.

The drive signal of the solenoid **7** which has been input to the power-supply control part **17** is transmitted from the power-supply control part **17** to the power-receiving control part **27** via the communication circuits **19** and **29**. The power-receiving control part **27** which has received the drive signal of the solenoid **7** drives the solenoid **7**. Once the solenoid is driven, the electronic lock **3** is switched from the locked condition to the unlocked condition or from the unlocked condition to the locked condition. As described above, the switching circuit **32** is in the primary state during normal operation where no power outage is detected by the power-outage detecting circuit **20**. In other words, during normal operation where no power outage is detected by the power-outage detecting circuit **20**, the switching circuit **32** is in the primary state; therefore, the solenoid **7** is powered by the power-receiving coil **14**. In other words, during normal operation where no power outage is detected by the power outage-detecting circuit **20**, electric power is supplied to the electronic lock **3** by the power-receiving coil **14** when the electronic lock **3** is switched from the locked condition to the unlocked condition or from the unlocked condition to the locked condition.

In this embodiment, the charging part **30** is being charged when the electronic lock **3** is in operation at a normal time in which no power outage is detected by the power outage-detecting circuit **20**; when the electronic lock **3** is in operation before the charging of the charging part **30** is completed, the electric power which is necessary to operate the electronic lock **3** (that is, to operate the solenoid **7**) and the electric power which is necessary to charge the charging part **30** is transmitted from the power-supplying coil **12** to the power-receiving coil **14**. Also, when the electronic lock **3** is in operation after the charging of the charging part **30** is completed ate normal time in which no power outage is detected by the power outage-detecting circuit **20**, the electric power which is necessary to operate the electronic lock **3** is transmitted from the power-supplying coil **12** to the power-receiving coil **14**.

The electric energy transmitted from the power-supplying coil **12** to the power-receiving coil **14** varies depending on the electric current supplied to the power-supplying coil **12**. Also, the electric current supplied to the power-supplying coil **12** varies depending on the current-supply signal which is input to the drive circuit **18**. In this embodiment, the charge complete signal is transmitted from the power-receiving control part **27** to the power-supply control part **17** via the communication circuit **19** and the communication circuit **29** as described above; the power-supply control part **17** generates a current supply signal based on the charge-complete signal and outputs the generated current supply signal to the drive circuit **18**. Also, the drive circuit **18** supplies the power-supplying coil **12** with the electric current which is generated responding to the current-supply signal.

Note that, in addition to the charging of the charging part **30** when the electronic lock **3** is in operation or instead of charging the charging part **30** when the electronic lock **3** is in operation, the charging part **30** may be charged when the electronic lock **3** is not in operation (that is, during the non-operating time of the electronic lock **3**). In other words, when the electronic lock **3** is not in operation, the electric power necessary to charge the charging part **30** may be transmitted from the power-supplying coil **12** to the power-receiving coil **14**. In this case, upon the completion of the charging of the charging part **30**, the power transmission from the power-supplying coil **12** to the power-receiving coil **14** is stopped. In other words, when the electronic lock **3** is not in operation after the charging part **30** is charged, the power transmission from the power-supplying coil **12** to the power-receiving coil **14** is stopped.

Also, in the electronic locking system **1**, once power outage is detected based on the detection result from the power outage-detecting circuit **20** and it is also detected,

based on the detection result by the lock sensor **8**,that the electronic lock **3** is in the locked condition, the switching circuit **32** is automatically switched to the secondary state in which electric power can be supplied to the electronic lock **3** by the charging part **30**, electric power is supplied to the electronic lock **3** from the charging part **30** and then the electronic lock **3** becomes unlocked. More specifically described, first of all, once power outage is detected, the power outage-detecting signal which has been input to the power-supply control part **17** is transmitted to the power-receiving control part **27** via the transmission reception circuits **19** and **29**. Receiving the power outage-detecting signal, the power-receiving control part **27** judges whether the electronic lock **3** is in the locked condition or not; when the electronic lock **3** is in the locked condition, the power-receiving control part **27** outputs the switching signal to the switching circuit **32** and outputs the drive signal to the drive circuit **28**.

Having the switching signal input, the switching circuit **32** is switched from the state in which the solenoid **7** and the charging part **30** are electrically disconnected to the state in which the solenoid **7** and the charging part **30** are electrically connected. Also, the drive circuit **28** drives the solenoid **7** with the power supplied from the charging part **30** to switch the state of the electronic lock **3** from the locked condition to the unlocked condition. Note that even when power outage is detected based on the detection result from the power outage-detecting circuit **20**, if it is detected based on the detection result by the lock sensor **9** that the electronic lock **3** is in the unlocked condition, the switching circuit **32** keeps the primary state and electric power is not supplied to the electronic lock **3**.

(Major Effects of This Embodiment)

As described above, in this embodiment, once power outage is detected based on the detection result from the power-outage detecting circuit **20** and it is also detected, based on the detection result by the lock sensor **8**, that the electronic lock **3** is in the locked condition, the switching circuit **32** is automatically switched to the secondary state in which power can be supplied to the electronic lock **3** from the charging part **30**, without a user's operation. In other words, once power outage is detected and it is also detected that the electronic lock **3** is in the locked condition, the electronic lock **3** which was in the locked condition when power outage has occurred is instantly driven so that the electronic lock **3** becomes unlocked immediately after power outage. Therefore, the electronic locking system **1** of this embodiment has an advantage of an electronic lock which is locked when powered, and in which the electronic lock **3** automatically becomes unlocked when power outage occurs and therefore power is not supplied to the electronic lock **3**. Also, in this embodiment, the electronic lock **3** is a type of an electronic lock which is instantly locked/unlocked when powered, in which electric power is consumed only when the electronic lock **3** is switched from the unlocked condition to the locked condition or from the locked condition to the unlocked condition. For this reason, power consumption by the electronic lock **3** can be reduced. Thus, in the electronic locking system **1** of this embodiment, power consumption of the electronic locking system **1** can be reduced while having the advantage of an electronic lock which is locked when powered.

In this embodiment, when power outage is detected and it is also detected that the electronic lock **3** is in the locked condition, electric power is supplied to the electronic lock **3** by the charging part **30**. Therefore, in this embodiment, the charging part **30** is less frequently charged/discharged. Therefore, the life of the charging part **30** can be increased.

In this embodiment, electric power is transmitted from the power-supplying coil **12** to the power-receiving coil **14** through contactless power transmission. In this embodiment, therefore, there is no need to draw a wire between the door **2** and the outer frame to which the door **2** is fastened by a hinge. Thus, installation of the electronic locking system **1** is easy in this embodiment. However, when power is supplied through contactless power transmission, power transmission efficiency is low, compared to the power transmission through wires; therefore, even if the same electric energy is supplied to the electronic lock **3** or the charging part **30**, the power consumption by the electronic locking system **1** tends to be greater. However, in this embodiment, the electronic lock **3** is an electronic lock which is instantly locked/unlocked when powered and power is consumed only when the electronic lock **3** is switched from the unlocked condition to the locked condition or from the locked condition to the unlocked condition, power consumption by the electronic locking system **1** can be reduced even if power is supplied through contactless power transmission.

In this embodiment, the electric power necessary to operate the electronic lock **3** and the electric power necessary to charge the charging part **30** is transmitted from the power-supplying coil **12** to the power-receiving coil **14** when the electronic lock **3** is in operation before the charging of the charging part **30** is completed; on the other hand, the electric power necessary to operate the electronic lock **3** is transmitted from the power-supplying coil **12** to the power-receiving coil **14** when the electronic lock **3** is in operation after the charging of the charging part **30** is completed. In other words, in this embodiment, the minimum electric power is transmitted from the power-supplying coil **12** to the power-receiving coil **14** when the electronic lock **3** is in operation. For this reason, in this embodiment, although power is supplied through contactless power transmission, the overall power consumption of the electronic locking system **1** can effectively be reduced.

Note that, as described above, the electric power necessary to charge the charging part **30** may be transmitted from the power-supplying coil **12** to the power-receiving coil **14**; in this case, once the charge to the charging part **30** is completed, power transmission from the power-supplying coil **12** to the power-receiving coil **14** is stopped. For this reason, even in this case, power consumption by the electronic locking system **1** can effectively be reduced.

(Other Embodiments)

The above-described embodiment is an example of an embodiment of the present invention, but is not limited to this and can be varyingly modified within the scope of the present invention.

In the above-described embodiment, when power outage is detected based on the detection result at the power outage-detecting circuit **20** and it is also detected based on the detection result by the lock sensor **8** that the electronic lock **3** is in the locked condition, the switching circuit **32** is switched to the secondary state in which power can be supplied to the electronic lock **3** from the charging part **30**, the electronic lock **3** is powered by the charging part **30**, and the electronic lock **3** becomes locked. Alternatively, for example, when power outage is detected based on the detection result at the power outage-detecting circuit **20** and it is also detected, based on the detection result by the unlock sensor **9**, that the electronic lock **3** is in the unlocked condition, the switching circuit **32** may be switched to the secondary state in which power can be supplied to the

electronic lock **3** from the charging part **30**, electric power is supplied to the electronic lock **3** from the charging part **30**, and the electronic lock **3** may become locked.

The electronic locking system **1** in this case has an advantage of an electronic lock which is unlocked when powered, which is automatically locked when power outage occurs and therefore no power is supplied to the electronic lock **3**. Also, in this case, power consumption by the electronic locking system **1** can be reduced in the same manner as the above-described embodiment. In other words, the electronic locking system **1** in this case can reduce power consumption by the electronic locking system **1** while having the advantage of the electronic lock which is unlocked when powered. Note that, in this case, even when power outage is detected based on the detection result at the power outage-detecting circuit **20**, if it is detected, based on the detection result by the lock sensor **8**, that the electronic lock **3** is in the locked condition, the switching circuit **32** remains in the primary state and therefore, no electric power is supplied to the electronic lock **3**.

In the above-described embodiment, when the power-receiving coil **14** and the charging part **30** are electrically connected, the charging part **30** is electrically connected to the solenoid **7**; when the power-receiving coil **14** and the charging part **30** are electrically disconnected, the charging part **30** and the solenoid **7** are electrically disconnected. Beside this, the switching circuit **32** may be configured such that the electrical connection between the charging part **30** and the solenoid **7** is switchable despite the electrical connection status of the receiving coil **14** with the charging part **30**. In this case, when the switching circuit **32** is in the primary state, the power-receiving coil **14** and the electronic lock **3** are electrically connected, but the electronic lock **3** and the charging part **30** are electrically disconnected; when the switching circuit **32** is in the secondary state, the electronic lock **3** and the charging part **30** are electrically connected.

In the above-described embodiment, the charging part **30** is connected to the power-receiving coil **14** via the switching circuit **32**; however, the charging part **30** may be connected to the power-receiving coil **14** without going through the switching circuit **32**. In this case, the switching circuit which switches the connection of the charging part **30** and the power-receiving coil **14** between the electrically connected condition and the electrically disconnected condition, is arranged between the charging part **30** and the power-receiving coil **14**, for example. Also, in the above-described embodiment, when the charging of the charging part **30** is completed, the power-receiving coil **14** and the charging part **30** become electrically disconnected; however, the power-receiving coil **14** and the charging part **30** may electrically remain connected electrically even after the charging of the charging part **30** is completed.

In the above-described embodiment, the electronic lock **3** is provided with the solenoid **7** as a drive source for driving a deadbolt; however, the electronic lock **3** may be provided with a motor as the drive source for driving a dead bolt. In other words, the electronic lock **3** may be a motor-driven locking/unlocking type electronic lock. Even in this case, in the same manner as the above-described embodiment, electric power is supplied to the electronic lock **3** [only] when the lock **3** is switched from the unlocked condition to the locked condition or from the locked condition to the unlocked condition, and the power supply to the electronic lock **3** is stopped after the lock **3** is switched from the locked condition to the unlocked condition or from the unlocked condition to the locked condition. Also, in this case, the charging part **30** is being charged with the electric power which is necessary to drive the motor until the electronic lock **3** is switched from the locked condition to the unlocked condition. Even in this case, the same effect as the above-described embodiment can be obtained.

In the above-described embodiment, the power-supplying part **13** is provided with the power outage-detecting circuit **20** that detects power outage; however, the system control unit **5** or the power-receiving part **15** may be provided with a power outage-detecting circuit which detects power outage. In the above-described embodiment, the electronic locking system **1** is a system to lock the door **2** so that the door won't open; however, the electronic locking system **1** may be a system to lock a fitting, such as a sliding door, a window or a shutter, so it cannot be opened.

In the above-described embodiment, electric power is transmitted from the power-supplying coil **12** to the power-receiving coil **14** by a magnetic field coupling method; however, power may be transmitted from the power-supplying coil **12** to the power-receiving coil **14** by other wireless methods such as an electromagnetic induction method. Also, in the above-described embodiment, the power-supplying device **4** supplies electric power by contactless power transmission; however, the power-supplying device **4** may supply electric power using a power source connected to the switching circuit **32** via a predetermined wiring. In this case, the power source connected to the switching circuit **32** via wiring functions as a power-supplying part to supply electric power to the electronic lock **3** and the charging part **30**.

While the description above refers to particular embodiments of the present invention, it will be understood that many modifications may be made without departing from the spirit thereof. The accompanying claims are intended to cover such modifications as would fall within the true scope and spirit of the present invention.

The presently disclosed embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims, rather than the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed is:

1. An electronic locking system provided with an electronic lock which becomes unlocked at the time of power outage, the electronic locking system comprising:

a lock detecting part structured to detect that said electronic lock is in the locked condition;

a power outage-detecting part structured to detect power outage;

a charging part structured to supply electric power to said electronic lock during the time of power outage;

a power-supplying part structured to supply power to said electronic lock and said charging part; and

a switching part structured such that power is supplied to said electronic lock from said power-supplying part in a primary state, and power is supplied to said electronic lock from said charging part in a secondary state;

wherein said electronic lock is an electronic lock which is locked/unlocked when powered or a motor-driven locking/unlocking-type electronic lock;

said switching part is structured to be in said primary state during normal operation where no power outage is detected by said power outage-detecting part, and when said electronic lock is switched from the unlocked condition to the locked condition or from the locked condition to the unlocked condition, electric power is

directly supplied to said electronic lock from said power-supplying part without going through said charging part; and

said switching part is structured such that, when power outage is detected, based on the detection result at said power outage-detecting part, and it is also detected, based on the detection result by said lock detecting part, that said electronic lock is in the locked condition, said switching part is switched from said primary state to said secondary state, electric power is supplied to said electronic lock from said charging part, and said electronic lock become unlocked.

2. The electronic locking system as set forth in claim **1**, further comprising:

a power-supplying coil which is wound to be air-cored and connected to a power source; and

power-receiving coil which is wound to be air-cored and arranged opposite said power-supplying coil with a predetermined gap;

wherein electric power is transmitted from said power-suppling coil to said power-receiving coil by contactless power transmission.

3. The electronic locking system as set forth in claim **2**, further comprising:

a charge detecting part structured to detect that the charging of said charging part is completed;

wherein said switching part is structured to keep said power-receiving coil and said charging part electrically connected until the charging of said charging part is completed, and electrically disconnect said power-receiving coil from said charging part when the charge to said charging part is completed;

when said electronic lock is in operation before the charging of said charging part is completed, electric power necessary to operate said electronic lock and electric power necessary to charge said charging part is transmitted from said power-supplying coil to said power-receiving coil; and

when said electronic lock is in operation after the charge to said charging part is completed, electric power necessary to operate said electronic lock is transmitted from said power-supplying coil to said power-receiving coil.

4. The electronic locking system as set forth in claim **2**, further comprising:

a charge detecting part structured to detect that the charge to said charging part is completed;

wherein said switching part is structured to keep said power-receiving coil and said charging part electrically connected until the charging of said charging part is completed, and electrically disconnect said power-receiving coil from said charging part when the charge to said charging part is completed;

when said electronic lock is not in operation before the charging of said charging part is completed, electrical power necessary to charge said charging part is transmitted from said power-supplying coil to said power-receiving coil; and

when said electronic lock is not in operation after the charging of said charging part is completed, power transmission from said power-supplying coil to said power-receiving coil is halted.

5. An electronic locking system provided with an electronic lock which becomes locked at the time of power outage, the electronic locking system comprising:

an unlock detecting part structured to detect that said electronic lock is in the unlocked condition;

a power outage-detecting part structured to detect power outage;

a charging part structured to supply electric power to said electronic lock during the time of power outage;

a power-supplying part structured to supply electric power to said electronic lock and said charging part; and

a switching part structured such that power is supplied to said electronic lock from said power-supplying part in a primary state, and power is supplied to said electronic lock from said charging part in a secondary state;

wherein said electronic lock is an electronic lock which locked/unlocked when powered or a motor-driven locking/unlocking-type electronic lock;

said switching part is structured to be in said primary state during normal operation where no power outage is detected by said power outage-detecting part, and when said electronic lock is switched from the unlocked condition to the locked condition or from the locked condition to the unlocked condition, electric power is directly supplied to said electronic lock from said power-supplying part without going through said charging part; and

said switching part is structured such that, when power outage is detected, based on the detection result at said power-outage detecting part, and it is also detected, based on the detection result at said lock detecting part, that said electronic lock is in the unlocked condition, said switching part is switched from said primary state to said secondary state, power is supplied to said electronic lock from said charging part, and said electronic lock becomes locked.

6. The electronic locking system as set forth in claim **5**, further comprising:

a power-supplying coil which is wound to be air-cored and connected to a power source; and

power-receiving coil which is wound to be air-cored and arranged opposite said power-supplying coil with a predetermined gap;

wherein electric power is transmitted from said power-suppling coil to said power-receiving coil by contactless power transmission.

7. The electronic locking system as set forth in claim **6**, further comprising:

a charge detecting part structured to detect that the charging of said charging part is completed;

wherein said switching part is structured to keep said power-receiving coil and said charging part electrically connected until the charging of said charging part is completed, and electrically disconnect said power-receiving coil from said charging part when the charge to said charging part is completed;

when said electronic lock is in operation before the charging of said charging part is completed, electric power necessary to operate said electronic lock and electric power necessary to charge said charging part is transmitted from said power-supplying coil to said power-receiving coil; and

when said electronic lock is in operation after the charge to said charging part is completed, electric power necessary to operate said electronic lock is transmitted from said power-supplying coil to said power-receiving coil.

8. The electronic locking system as set forth in claim **6**, further comprising:

a charge detecting part structured to detect that the charge to said charging part is completed;

wherein said switching part is structured to keep said power-receiving coil and said charging part electrically connected until the charging of said charging part is completed, and electrically disconnect said power-receiving coil from said charging part when the charge to said charging part is completed;

when said electronic lock is not in operation before the charging of said charging part is completed, electrical power necessary to charge said charging part is transmitted from said power-supplying coil to said power-receiving coil; and

when said electronic lock is not in operation after the charging of said charging part is completed, power transmission from said power-supplying coil to said power-receiving coil is halted.

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